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ABSTRACT

Noting that electronic technology is becoming more advanced and more available, this paper argues that current conceptions of literacy as the ability to read and write should be expanded to include electronic reading and writing. The paper discusses: (1) four ways in which electronic texts are different from printed texts; (2) how students can be prepared to read and write electronically; and (3) issues related to electronic reading and writing that are likely to become important in the future. The paper offers information from research that should be helpful in answering current questions on electronic literacy. While not suggesting that electronic literacy is more important than conventional print-based literacy, the paper suggests that educators must include the reading and writing of both electronic and printed texts in their definition of literacy as well as in their approach to helping children become literate. Contains 30 references and 5 figures representing aspects of electronic texts. (RS)

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Electronic Literacy

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U.S. DEPARTMENT OF EDUCATION

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PERSPECTIVES IN READING RESEARCH NO. 4
Spring 1994

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National Reading Research Center

Electronic Literacy

David Reinking
University of Georgia

PERSPECTIVES IN READING RESEARCH NO. 4
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The National Reading Research Center (NRRC) is funded by the Office of Educational Research and Improvement of the U.S. Department of Education to conduct research on reading and reading instruction. The NRRC is operated by a consortium of the University of Georgia and the University of Maryland College Park in collaboration with researchers at several institutions nationwide.

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David Reinking is Professor of Education at the University of Georgia where he serves as head of the Department of Reading Education. He is also a principal investigator with the National Reading Research Center and serves as receiving editor for the Center's research reports. Professor Reinking's primary research interest is the connection between technology and literacy. His research publications in this area have appeared in *Reading Research Quarterly*, *Journal of Reading Behavior*, and *Handbook of Reading Research*. He edited *Reading and Computers: Issues for Theory and Practice* (published by Teachers College Press), and has written a commercial software program for increasing reading comprehension, which has been distributed nationally to elementary and secondary schools. He recently completed an NRRC project investigating how elementary school students' creation of multimedia book reviews might increase their independent reading. Dr. Reinking taught reading and math at the elementary school level for eight years.

National Reading Research Center
Universities of Georgia and Maryland
Perspectives in Reading Research No. 4
Spring 1994

Electronic Literacy

David Reinking
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Simply defined, literacy is the condition of being able to read and write. For most people this definition is adequate. However, it is becoming increasingly apparent that educators and educational policy makers must now expand their definition of literacy to include the reading and writing not only of printed texts but of electronic texts. As educators look for new ways to help children become more literate, and as electronic technology becomes more advanced and more available, expanding our ideas about what it means to be literate seems almost inevitable.

Until recently, educators could safely confine reading and writing activities to printed materials. Increasingly, however, reading and writing can be done electronically with the aid of a computer. Computers are being used to create and revise texts, to send and receive mail electronically, to present instructional texts on-screen instead of in printed books, and to access large databases of texts. And electronic texts are becoming more prevalent as computers become an integral part of everyday experiences such as working, shopping, traveling, and studying. Clearly, educators must include electronic forms of reading and writing in their conception of literacy; as part of that process, I suggest that they consider three questions: (1) How are electronic texts different from printed texts? (2) How can students be prepared to read and write electronically? and (3) What issues related to electronic reading and writing are likely to become important in the future? In this paper, I offer information, drawn from my own research as well as that of my colleagues who share my interest in technology and literacy, that should be helpful in answering these questions.

I argue here that current conceptions of literacy should be expanded to include electronic reading and writing. This type of literacy, which might be called electronic literacy, is different from conventional print-based literacy. As I will show in subsequent sections, these differences represent more than subtle

differences in the context and purpose of reading and writing. Instead, electronic texts have unique characteristics that make them fundamentally different from conventional texts.

Our familiarity with the conventions of reading and writing printed texts tends to obscure the unique characteristics of electronic texts. It is easy to think of electronic texts as little more than printed texts displayed on a computer screen, and perhaps to characterize them, in some unspecified way, as inferior to printed texts. The whole idea of electronic literacy may require deep and perhaps disquieting adjustments in our conceptions of literacy, some of which may even be threatening to those with a life-long affinity for printed materials. However, I am not suggesting that electronic literacy is more important than conventional print-based literacy or that it should replace our traditional notions of what literacy means — at least not in the immediate future. I am simply saying that educators must include the reading and writing of both electronic and printed texts in their definition of literacy as well as in their approach to helping children become literate.

CHARACTERISTICS OF ELECTRONIC TEXTS

In this section, I briefly discuss four fundamental differences between printed and electronic texts. A more extensive discussion of these differences can be found elsewhere (see Reinking, 1992). These differences lay the groundwork for my argument that conventional print-based conceptions of literacy should be expanded to include electronic literacy. These differences also provide a base for considering what kinds of activities might help students develop electronic literacy. After explaining each difference, I will provide illustrative examples.

Readers and Texts Can Interact

Reading is often described as an interaction between a reader and a text. However, readers and printed texts cannot literally interact. A printed text cannot respond to a reader, nor do printed texts invite modification by a reader. To describe reading as an interaction simply reflects the fact that the outcomes of reading are the result of factors associated with the text and factors associated with the reader. What the reader comprehends during reading is the result of the visual and linguistic features of the text as they interact with the affective and cognitive characteristics of the reader.

Because reading is interactive in this sense, a successful reader must be cognitively active during reading. Because readers vary greatly in their cognitive capabilities and orientations, understanding the reader has come to be seen as basic to understanding the process of reading. Features of printed texts, such as the use of illustrations, are not discounted entirely (e.g., Waller, 1991); however, the role of the printed text has been clearly deemphasized in the literature about literacy over the past 20 years. One reason for a greater interest in readers than in texts is that texts are static and inert once they are printed. When a writer's intended meaning is viewed as frozen in a printed form, it is only logical to focus on a reader's efforts to construct meaning from the printed page.

Successful readers of printed texts know that they bear the responsibility for deriving

meaning from those texts, and they approach the task of reading accordingly. A printed text cannot clarify itself if the reader is having difficulty understanding it. In a figurative sense, readers may consciously interact with a text by applying their own knowledge to it, but they cannot literally carry on a dialogue with a printed text. In fact, reading strategies that are characteristic of good readers can sometimes be explained by the fact that they know it is impossible to interact with a text. For example, Freebody and Anderson (1983) found that it was necessary to replace many words in a passage with low-frequency synonyms before comprehension decreased appreciably. They suggested that readers may be using a minimum effort principle when confronted with difficult vocabulary in a text. In other words, readers may find it easier to rely on other elements of the text for meaning than to deal directly with an unfamiliar word. Such a strategy may be explained by the fact that it is often inconvenient or impractical to seek out the meaning of unfamiliar words while reading independently.

Electronic texts, on the other hand, can effect a literal interaction between texts and readers (Daniel & Reinking, 1987; Duchastel, 1988; Reinking, 1987). Given the capabilities of the computer, reading electronic texts can take on the characteristics of a dialogue. Electronic texts can be programmed to adapt to an individual reader's needs and interests during reading, which may in turn affect the strategies readers use to read and comprehend texts. For example, in a recent study Sharon Rickman and I (Reinking & Rickman, 1990) tried to determine what would happen if an electronic text enabled readers to request a context-specific definition of difficult words in a text during reading. We compared the effects of reading under such conditions to reading printed texts accompanied by conventional resources such as a dictionary or glossary. Our results suggest that when reading two short passages adapted from a science text, middle-grade students reading the interactive computer texts investigated more wor[illegible]eanings, recalled the meanings of more words, and comprehended more of the experimental text.

In my previous work, I have found that comprehension can be increased by using electronic texts that provide a variety of options for readers and texts to interact during reading (see Reinking, 1988; Reinking & Schreiner, 1985; see also Blohm, 1982, 1987; MacGregor, 1988a, 1988b). Figures 1-3 show three screens from a current version of an electronic text about physics that I use in my research. Figure 1 shows the first paragraph of the main text. The icons at the bottom of the screen represent readers' options for increasing their understanding of the text, which include: (a) assistance with the meaning of difficult vocabulary words or phrases; (b) an illustration related to the content of the text displayed, which is often animated; (c) useful background information; (d) a map of the text's structure; and (e) an easier, less technical version of the text displayed. Figure 2 shows the third paragraph in the main text after a reader has requested assistance with the meaning of the term *impetus theory*. By selecting one of the icons at the bottom of the screen, a reader can access (a) a dictionary definition, (b) the word's pronunciation, (c) an illustration explaining the concept, and (d) a concordance providing all instances of the word displayed in

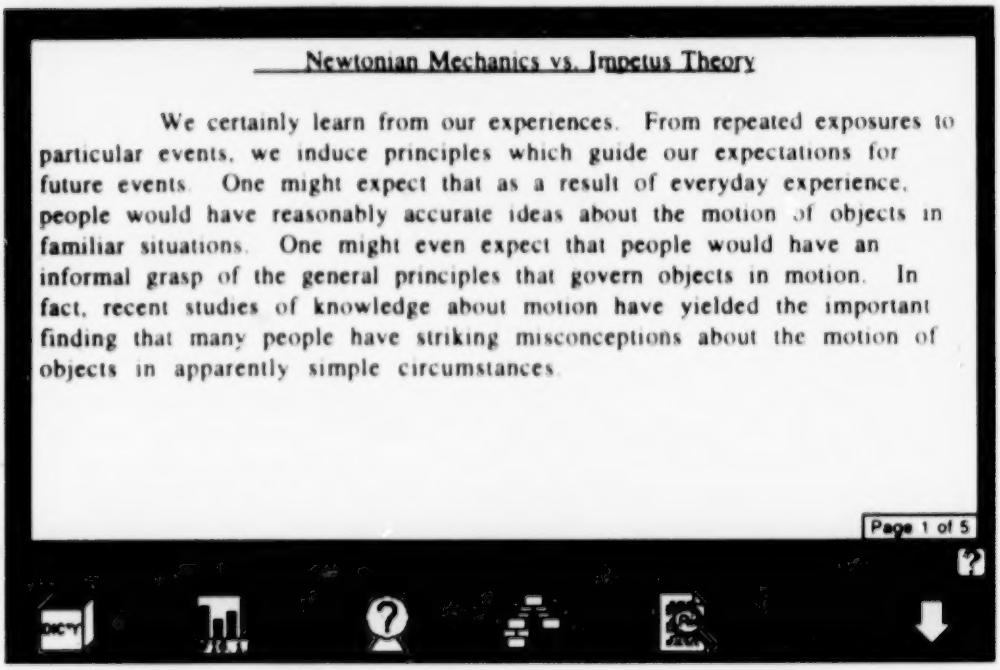
Newtonian Mechanics vs. Impetus Theory
We certainly learn from our experiences. From repeated exposures to particular events, we induce principles which guide our expectations for future events. One might expect that as a result of everyday experience, people would have reasonably accurate ideas about the motion of objects in familiar situations. One might even expect that people would have an informal grasp of the general principles that govern objects in motion. In fact, recent studies of knowledge about motion have yielded the important finding that many people have striking misconceptions about the motion of objects in apparently simple circumstances.
Page 1 of 5

Figure 1. Computer screen showing first paragraph of main text on Newtonian mechanics. Icons at the bottom show readers' options for increasing their understanding of the text.

sentences from the current text. Figure 3 shows the screen that appears when a reader requests to see the text's structure. The map of the text's structure on that screen highlights how paragraphs 3-5 are related.

Electronic texts can also be presented so that they respond automatically to certain characteristics of the reader. Like a teacher who adapts instruction to individual students, a computer can be programmed to monitor the activities of the reader and to adapt the text accordingly. For example, L'Allier (1980) created an electronic text in which the text was modified during reading based on a complex algorithm that included subjects' reading rate, their accuracy, and the time required to answer inserted questions. He found that secondary school students who were poor readers but who read the adaptive electronic texts performed as well as good readers who read printed texts that were not adapted.

The range of possibilities for creating electronic texts that interact with individual readers is limited only by the fact that the input (at least for the present) must be electronic and digital. Although keystrokes or the movements of a mouse readily fit this criterion, more intriguing possibilities are imaginable. For example, it is possible with current technology to create electronic texts that monitor physical

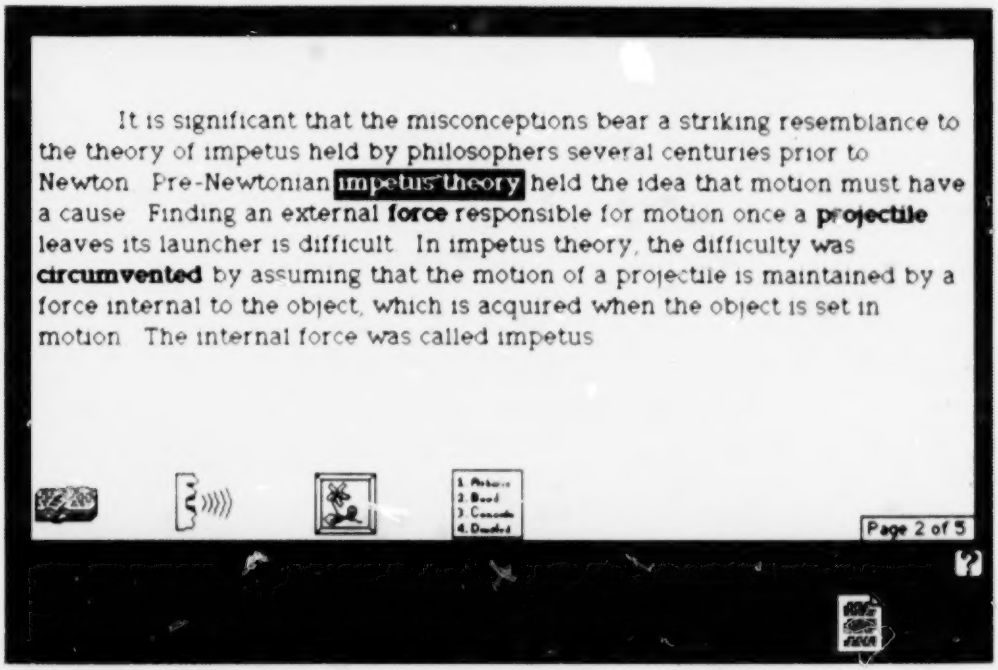
It is significant that the misconceptions bear a striking resemblance to the theory of impetus held by philosophers several centuries prior to Newton. Pre-Newtonian impetus theory held the idea that motion must have a cause. Finding an external force responsible for motion once a projectile leaves its launcher is difficult. In impetus theory, the difficulty was circumvented by assuming that the motion of a projectile is maintained by a force internal to the object, which is acquired when the object is set in motion. The internal force was called impetus
Page 2 of 5

Figure 2. A computer screen showing the third paragraph of the main text. The words *impetus theory* are highlighted because the reader has requested assistance with this term.

movements such as eye fixations or physiological changes such as galvanic skin response, which may be indicators of a reader's comprehension difficulty and anxiety. Based on such input, the textual presentation could be adapted accordingly.

Reading Can Be Guided

The previous examples illustrate how electronic texts can respond to individual readers. This capability makes reading literally an interactive experience in which texts play an active role during reading. But not only can a computer present texts that respond to a reader, it can determine which portion of a text a reader is permitted to see. Thus, electronic texts introduce an unprecedented capability of influencing what a reader attends to during reading.

An example will illustrate how the computer's ability to guide reading by controlling the reader's access to text might affect the reader's comprehension and reading strategies. In a recent study, Michael Pickle and I (Reinking & Pickle, 1990) extended Tobias's (1987, 1988) research investigating the effects of *mandatory review of relevant text* after a reader responded incorrectly to a question inserted in the text. Mandatory review during independent reading (i.e., requiring a reader to review a portion of

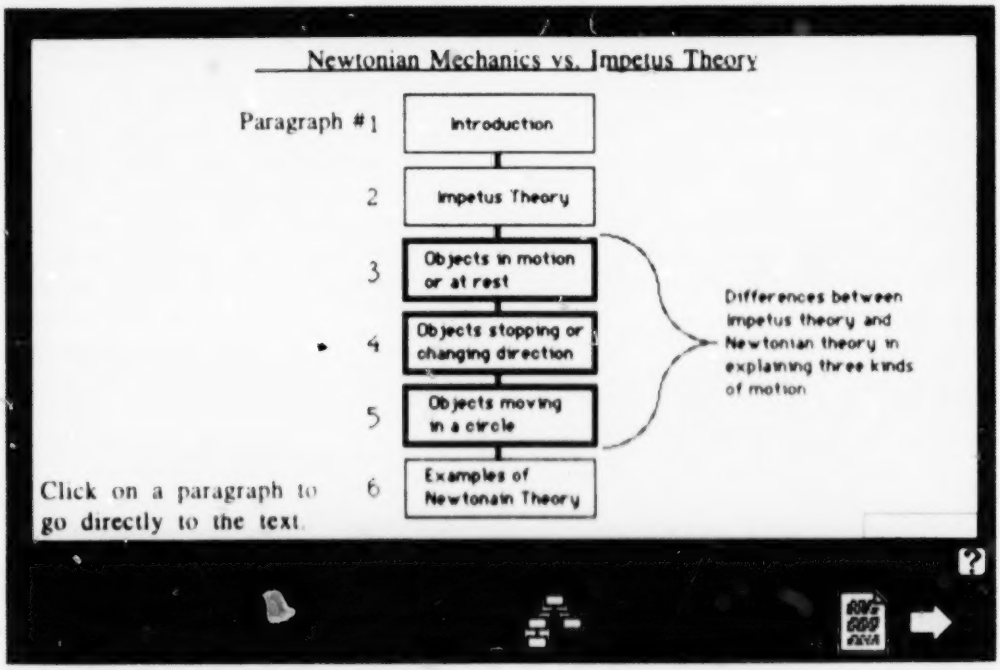

Figure 3. A computer screen showing the structure of the text on Newtonian mechanics and the relationship of paragraphs 3-5 in the main text.

a text) is feasible only when a text is presented electronically. Readers typically control access to all portions of a printed text because the entire text is available for inspection; however, only relatively short texts can be displayed in their entirety on a computer screen. The computer screen is like a window through which selected portions of a text may be viewed (see Wilkinson, 1983). Thus, access to portions of an electronic text is limited by the size of the computer screen. In many computer applications, the reader has complete control over what text is displayed on the screen, but this need not be the case. A computer can be programmed to display text only after certain conditions have been met. Thus, electronic texts can be displayed so that readers have unlimited access to all of the text (albeit with relatively small segments displayed at one time) or so that readers' access to specific portions of the text is greatly restricted. Similarly, the computer can vary the size of the textual segment displayed at one time, for example, from a word to a lengthy paragraph. On the other hand, it can allow readers to search texts flexibly for words and phrases. An electronic text can closely monitor and control a reader's access to text, but it can also help a reader locate specific information in a primary text or in other ancillary texts that may be

accessed from a large database. The simultaneous availability of powerful means to restrict and to expand a reader's access to texts is a unique characteristic of electronic texts.

In our study, we were interested in pursuing Tobias's findings that mandatory review increased comprehension but also heightened a potentially negative aspect of inserting questions in text. That is, subjects typically do better on a posttest when responding to the questions that have been inserted, but they often do worse on new questions related to other content in experimental passages. Tobias's findings suggest that mandatory review heightened this effect because subjects seemed more likely to focus only on the portion of a text related to the question they were asked during mandatory review.

To investigate this hypothesis and to see whether we could use the capabilities of electronic texts to change readers' review strategies, we compared subjects' reading and responding to inserted questions as they read three different versions of an electronic text: (a) inserted questions followed by feedback only, (b) missed questions followed by mandatory review until the original question was answered correctly, and (c) missed questions followed by mandatory review followed by a new question until one of the questions was answered correctly. We tracked the time subjects spent reviewing paragraphs containing information related or unrelated to the inserted question. Although there are many qualifications to our analyses and conclusions, we did find that mandatory review encouraged a local review strategy when followed by the same question but a more global review strategy when followed by a different question.

Our study is but one illustration of how electronic texts can guide reading by controlling a reader's access to text and how such a capability might influence reading. It shows how electronic text increases the importance of textual factors during reading because it permits texts to be presented in ways that directly influence reading strategies. Using this capability constructively and acknowledging its implications for developing reading and writing ability is an example of how electronic texts extend the concept of literacy based on printed texts alone.

The unprecedented options for both controlling *and* extending access to text illustrate how electronic texts may challenge conventional literacy. For example, the reviewers of earlier drafts of this paper reacted strongly to my discussion of how electronic texts can guide reading by controlling readers' access to text. They were concerned about the possible negative ramifications of controlling access to text, and they recommended revisions ranging from dropping this section entirely to emphasizing the potential dangers of control. There are potential dangers in controlling access to texts, and some imaginable scenarios may offend those with democratic ideals. However, I argue that electronic texts do not necessarily effect an increase in the potential for abusing control as much as they simply make issues of control more obvious.

The problem of control surfaces regularly in the world of printed texts. Examples of censorship are as easy to find as picking up the daily newspaper. However, a teacher who decides what is good children's literature and consequently purchases for the classroom library only those books deemed "good" is also

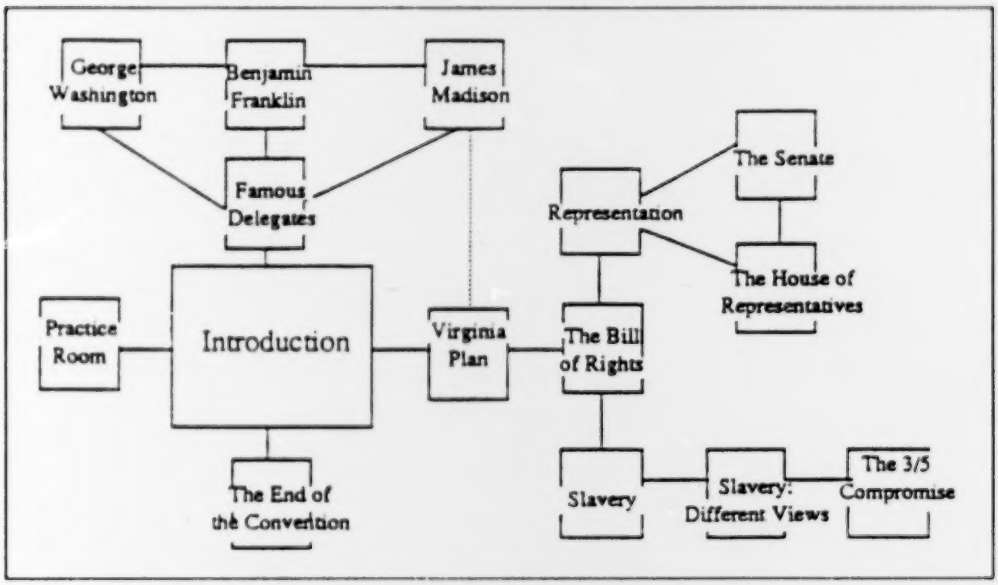

Figure 4. A diagram showing the topics of textual nodes and their links to other nodes in a hypertext developed by Peters (1988).

exercising a form of control, as is a teacher who selects one textbook and rejects another. Given the constraints of the printed textual world, however, these teachers' actions seem to be little more than a natural consequence of expediency, that is, the need to conform to a limited space and budget for books. When control is exercised in the world of electronic texts, on the other hand, limiting readers' access to text is clearly in the realm of conscious intent and can rarely be disguised as expediency. Because a wide range of texts can be made readily available to the reader of electronic texts, any attempts to limit access to those texts tends to be conscious and obvious. Likewise, expediency also dictates that writers of printed texts must speak with one voice and that readers are constrained by a rhetorical structure determined by the author. Electronic texts demand no such expediencies. Electronic texts allow authors to assume different voices in the same text, which can be written in ways that invite readers to create their own rhetorical structure as in the nonlinear writing that defines hypertexts, which are electronic documents stored as nonsequential texts (see Bolter, 1991).

Thus, issues of control that emerge in a consideration of electronic texts do not compare directly to the control routinely exercised and accepted as part of print-based literacy. Our concern about the possibilities for controlling a reader of electronic texts may only be an artifact of our assumptions about printed mate-

rials, assumptions that make the control exercised in printed texts transparent. Indeed, the capability of electronic texts to liberate readers from the natural barriers to accessing printed materials seem far more noteworthy. To me, the power of that capability is an effective counterweight to potential abuses of control that exist in *both* the printed and electronic textual worlds.

Because control of textual access is more obvious in electronic texts, it becomes an issue that moves from a peripheral to a more central concern as educators formulate new conceptions of literacy. This fact is evidenced by the strong reservations my reviewers expressed and by my extended response to those reservations here. Other than obvious examples of censorship, the current discussions of control in reading and writing are often limited to esoteric discussions of literary theory and criticism. For example, consider the following statement by Cherryholmes (1993) in his discussion of how different types of literacy criticism might affect power relations in printed texts: "It is often useful to accede power to texts because texts, in turn, enhance the reader's power in other situations from how to drive a car to how to cook an omelette to how to pour concrete" (p. 13). Cherryholmes's comment is embedded within an abstract discussion of literary theory, but it has much more concrete implications when applied to how electronic texts can guide readers by controlling their access to text.

Thus, issues of control are always a part of conceptualizing literacy. My point is that control is no more an issue in electronic texts than in printed texts; it is just more obvious and therefore more central to a conception of electronic literacy.

Electronic Texts May Have Different Structures

The idea that textual information might be structured differently if it is stored electronically is not new. In 1945, Vannevar Bush, a U.S. Presidential adviser, proposed that researchers develop electronic means for linking related information in a large database of microfilm documents. In 1960, Nelson introduced the term hypertext in referring to electronic documents structured as nonlinear, nonsequential texts (see Lunin & Rada, 1989). According to Rada (1989), hypertexts have the following three attributes that separate them from conventional, hierarchically structured printed texts: (a) a database consisting of distinct textual units; (b) a semantic network connecting the textual units (the textual units becoming nodes in the network); and (c) electronic tools for moving flexibly through the network. A diagram showing the topics of textual nodes and their links to other nodes in a typical hypertext developed by Peters (1988) is presented in Figure 4. The technology available when the concept of hypertext was first proposed did not permit easy and widespread implementation of this concept. The rapid increase in available computing power and memory over the past several years has renewed interest in hypertexts, and they are becoming more prevalent in practice and in theoretical frameworks for characterizing electronic texts (e.g., Bolter, 1991; Duchastel, 1986).

It may be difficult to see the usefulness of alternatively structured texts such as hypertexts because organizing information hierarchically is a fundamental component of our schema for written texts. When one becomes familiar with the alternative structures that are natural to electronic texts, it is possible to see their utility. For example, I recently worked as a member of a team preparing the proposal to obtain funding for the National Reading Research Center (NRRC). A major portion of the proposal involved describing approximately 40 research projects that the funding would support. Our team faced the problem of organizing the 40 projects around several dominant research themes but showing simultaneously that a project logically grouped under one theme was also relevant to a project grouped under another theme. Without elaborate and cumbersome cross-referencing, a conventional outline made it difficult to accomplish both goals simultaneously. Presenting the projects in a hypertext format would have solved the problem. Hypertexts are much more amenable to presenting information in semantic networks that enable meaning to emerge from highly interrelated concepts and ideas. Dominant themes in the proposal could have been displayed readily as could secondary relationships, and a reader could have explored the network in a fashion that was personally meaningful. The fact that the proposal was not presented as a hypertext was due partly to a lack of electronic literacy.

Some preliminary research findings suggest that the way information is structured in hypertexts may affect learning in ill-structured domains of knowledge. For example, in research conducted by Spiro and his colleagues (see Spiro, Coulson, Feltovich, & Anderson, 1988), medical students were asked to read a conventional hierarchical text or a hypertext presenting information related to making a medical diagnosis. Students reading the conventional printed text scored higher on a recall of factual information, but those reading the hypertext scored higher on applying the information when conducting a diagnosis. Hypertexts may enrich internal representations of knowledge by requiring readers to create their own scaffolding for textual information and by providing an opportunity for more individualized approaches to creating connections among complex, interrelated texts.

Such findings support the need for a new conception of literacy that recognizes the unique characteristics of electronic texts. The fact that electronic texts can be structured differently also brings the difficulties inherent in developing electronic literacy into sharp focus. Becoming literate for electronic reading and writing will require that readers and writers become acquainted with the nonlinear, nonsequential text structures that are the natural form of electronic texts. They will also need to develop appropriate strategies for reading and writing such texts.

Some progress toward this goal has occurred naturally, however. For example, even casual users of computers are familiar with menus, which can be thought of as a structural element of electronic texts. In addition, the increasingly popular and widely used authoring systems, such as Hypercard for the Macintosh computer, encapsulate the characteristics of hypertexts. As they become more common,

the structural components of these systems, which are often displayed pictorially on a computer screen, may eventually become internalized metaphors for electronic reading and writing (see Bolter, 1991).

Electronic Texts Employ New Symbolic Elements

Part of being literate is being facile in using all of the symbolic elements that are available for communicating meaning in a written language. Readers and writers must know the conventions for using the symbolic elements and understand how these elements convey meaning in a written language. Such awareness includes being able to use and interpret symbolic elements such as graphic aids (e.g., illustrations and tables), organizational units (e.g., chapters), and typographical markers (e.g., underlining or italics).

Electronic texts can incorporate more symbolic elements than printed texts can. For example, symbolic elements used with electronic texts but not typically with printed texts include: flashing, animated, or moving visual displays; sound effects; and live-action video. These elements create new possibilities for communicating meaning and they create the need for new conventions for using them in conjunction with prose. The availability of more symbolic elements is problematic in the development of electronic literacy. Widely accepted conventions for using the various symbolic elements in electronic texts have not been established. Part of the problem is that the symbolic elements readily available for use in electronic texts continue to expand rapidly, and the conventions for using them change with each advance in computer technology. For example, the symbolic elements and conventions associated with reading an electronic text on a microcomputer 15 years ago are not the same as those associated with reading texts on today's relatively powerful microcomputers, especially when they are interfaced with an array of peripheral devices such as videodisc players.

In addition, there is a trend toward using more symbolic elements in the design of computer-based instructional materials. This trend is evidenced by multimedia programs — programs that combine written prose, audio in the form of speech and sound effects, live-action video, computer-generated and digitized graphics, and so forth. Supporting this trend is the rapid increase in the memory and speed of personal computers. The availability of sophisticated but easy-to-use authoring systems allows even elementary school children to create multimedia presentations, as my colleagues and I are discovering in an NRRC research project currently underway. Figure 5 shows how a multimedia hypertext program about the origins of the U.S. constitution may lead to new conventions for writing and reading texts (see Peters, 1988). For example, the box identified by a circled 5 provides a reader with a map that is a navigational aid indicating the textual node displayed, and other nodes displayed previously (the shaded boxes). A reader who clicks on the film projector (see the circled *10*) can see a video of the events involving Franklin or hear someone reading part of a speech he made to the convention delegates. A reader may move to related topics by

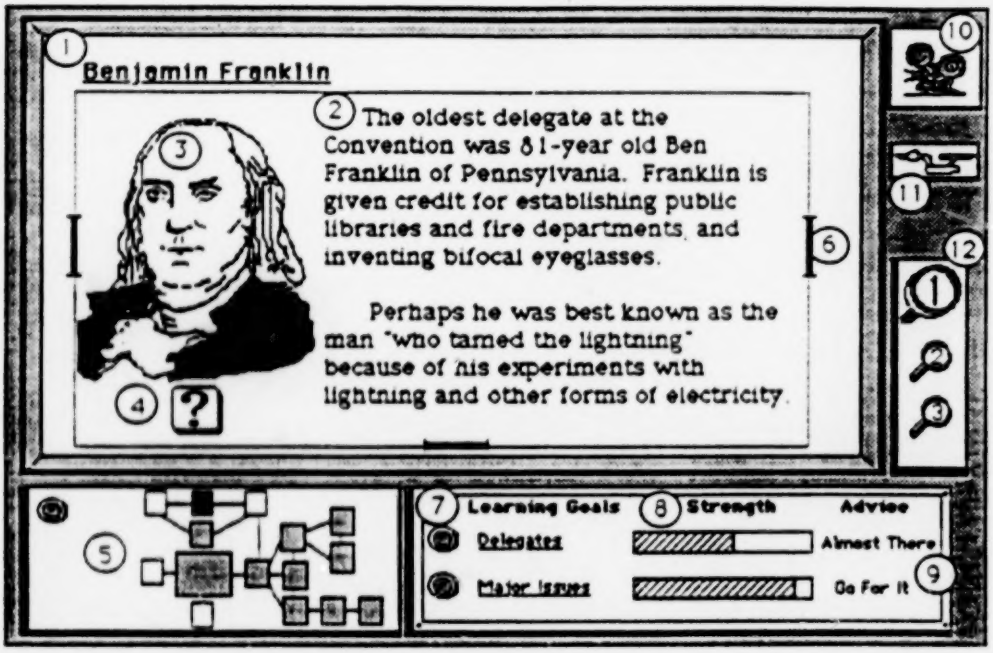
1
Benjamin Franklin
2 The oldest delegate at the Convention was 81-year old Ben Franklin of Pennsylvania. Franklin is given credit for establishing public libraries and fire departments, and inventing bifocal eyeglasses.
Perhaps he was best known as the man "who tamed the lightning" because of his experiments with lightning and other forms of electricity.
3
4
5
6
7 Learning Goals
8 Strength
Advice
Delegates
Almost There
Major Issues
Go For It
9
10
11
12

Figure 5. Screen from a Multimedia Hypertext Developed by Peters (1988). Circled numbers indicate various functions available to aid the reader.

clicking on one of the three "doors" around the box in which the text appears (one door is identified by a circled 6). When a door is selected, a reader hears the sound of a squeaky door opening and closing.

An example of how electronic texts may change the relations between symbolic elements is that in electronic texts graphic material is more closely integrated with prose. In printed materials, prose and graphic elements such as tables, charts, and diagrams are more likely to be seen as separate symbol systems, each with its own symbolic elements and conventions for using them. My colleagues and I (Reinking, Hayes, & McEneaney, 1988) have investigated means for bringing prose and graphic displays closer together by cueing readers' attention to graphic aids at appropriate points in printed texts. This cueing appears to increase attention to and learning from graphic aids and to increase some readers' comprehension of the prose material. However, such cueing is not necessary in electronic texts. Graphic aids and associated portions of the prose can be juxtaposed in a variety of formats that create a seamless integration of these two

symbol systems. The graphic information illustrating a complex process, for example, can be animated at the same time that relevant prose is fading in and out of view on the same screen.

As these examples illustrate, graphic aids and prose can be more clearly integrated in electronic texts because symbolic elements that are not available in printed texts can be used. Included in electronic literacy, then, is the ability to use these elements effectively in reading and writing electronic texts.

DEVELOPING ELECTRONIC LITERACY IN EDUCATIONAL CONTEXTS

The increasing use of electronic texts suggests to me that educators should begin considering how activities aimed at developing electronic literacy can be integrated into educational contexts. Ideally, these activities should meet four criteria. First, they should relate to conventional print-based literacy in meaningful ways. For the present, printed materials still dominate written communication and should remain the prime concern of educators. Fortunately, as the examples that follow illustrate, it is not difficult to address literacy for printed and electronic texts simultaneously. A second criterion is that activities designed to promote electronic literacy should involve authentic communication and meaningful tasks for students and teachers. Again, it has been my experience that activities highlighting the unique features of electronic reading and writing tend to meet this criterion. Third, activities should engage students and teachers in higher levels of thinking about the nature of printed and electronic texts as well as about the topics of their reading and writing. Activities that combine printed and electronic texts usually allow students and teachers to compare fundamental differences in these media. Fourth, activities should engage students and teachers in ways that allow them to develop functional strategies for reading and writing electronic texts. In the remainder of this section, I provide several examples of activities that I believe meet these criteria. I have selected examples from different educational levels, and for each example I highlight one or more of these four criteria along with some potential research questions each example might inspire.

Electronic literacy can be fostered in ways that will also enhance children's ability to learn to read printed texts. Electronic texts can provide support that beginning readers need in order to focus on meaning and at the same time help them learn to identify words. For example, Reitsma (1988) had six- and seven-year-old children read texts on a computer; children could request the pronunciation of unfamiliar words during reading. In this experimental condition, children's reading fluency increased more than did two comparison groups of print readers and was equal to that of children who had been given explicit guidance by a teacher who heard them read aloud. This study did not specifically address comprehension, but it is reasonable to expect that students are more likely to focus on the meaning of the text when given timely help with unfamiliar words. Children and their teachers also see that electronic texts can facilitate higher levels of inde-

pendent reading and understanding. Further, by engaging in such activities, they experience reading electronic texts that are interactive, that respond to their needs, and that use symbolic elements not found in printed texts. The long-term effects of reading such texts on reading ability are unknown, but would supply an interesting research question.

An example from the middle grades comes from a year-long research project my colleagues and I have recently completed. We wanted to know how students' reading and writing would be affected by having them enter book reviews on the computer as an alternative to required book reports. These reviews would form a collection of data organized so that search and retrieval would be possible. Students actually helped organize the data; they helped us design a form on the computer screen that contained fields for a variety of information they thought would be useful in searching for a book. This application seemed to enhance authentic communication in classroom reading and writing activities and encouraged more independent reading. It also familiarized students with the use of procedures and strategies for seeking out textual information in a computer database. In a current NRRC research project, we are extending this intervention by investigating whether having students create multimedia book reviews increases the amount and diversity of their independent reading.

Frances Teague, a colleague in the English Department at the University of Georgia, has built her undergraduate Shakespeare course around the use of electronic texts. Throughout the course, students have access to powerful functions for searching texts that are provided by computer terminals linked to a file server containing all of the known works of Shakespeare. She engages her students in a variety of activities revolving around their ability to search rapidly for key words in Shakespeare's works. Her students complete term papers based on their discoveries about, for example, where and when Shakespeare typically has a character employ a weapon such as a sword. As newer technologies such as CD-ROM become more affordable and widely available, many schools will have access to information contained in voluminous databases of text and to powerful and flexible tools for finding information across a variety of texts simultaneously. Research will be needed to investigate readers' strategies for searching and retrieving information under such circumstances as my NRRC colleagues John Guthrie (see Guthrie, Britten, & Barker, 1991) has done and Cynthia Hynd and Steve Stahl are doing in a project that is currently underway.

At the graduate level, I have provided students with first-hand experiences in reading and writing electronic texts in a course I teach entitled "Topics in Computer-Based Reading and Writing." The textbook that I currently use in the course (Bolter, 1991) is written both as a conventional textbook and as a hypertext. Part of the course focuses on a comparison of students' experiences and reactions to reading both forms of the text. I require students to write a paper for the course and encourage them to write their paper as a hypertext using a word processing program designed for that

purpose. Students also enjoy reading *Afternoon* (Joyce, 1987), a serious novel written as a hypertext, and we use it as a focus for a discussion about the potential of hypertexts as an artistic medium for writers. Students' comments suggest that their experiences with electronic texts in the course expand their conceptions of literacy. An interesting line of research would be to investigate how students approach the writing and reading of hypertexts.

THE FUTURE OF ELECTRONIC LITERACY

From our present vantage point, the future of electronic literacy is difficult to predict. Will current conceptions of literacy based on printed texts be replaced by a much different conception of literacy based on electronic texts? Such a possibility does not seem as farfetched today as it might have only a few years ago. Indeed, Bolter (1991) has argued convincingly that we are living in the late age of print. To Bolter, the history of literacy can be viewed in terms of a construct he refers to as the writing space, which is "the physical and visual field defined by a particular technology of writing" (p. 11). He contends that each new technology of writing creates a new writing space that exerts a powerful and pervasive effect on literacy. The genres and uses of writing within a culture are determined by "the dynamic relationship between the materials and techniques of writing" (p. 37). He concludes that the intellectual advantages of hypertexts are so compelling that they are destined to replace the book as the dominant form of written communication.

A future in which electronic texts play a more dominant role will require that we rethink some common notions associated with a literacy based on print alone. For example, it is much more difficult to identify a single text as a distinct physical entity in an electronic medium. What is *the* text when a reader explores divergently a large database of textual information that may originally have been separate works by separate writers or editors? We are aware that two readers do not experience and comprehend a single printed text in exactly the same way. This awareness is a consequence of focusing on the reader in understanding the reading process. Electronic literacy, however, extends this diversity to the text itself.

Similarly, what will happen to the gatekeeping functions currently performed by various journals and editors when electronic forms of communication make written information more directly accessible to diverse populations of readers? Should plagiarism as we now define it be discouraged in electronic texts that by their nature invite readers to also become writers? More to the point, who is the author of an electronic text that may have been modified repeatedly by many readers? These and similar questions are raised by electronic literacy.

Books and other printed materials are not likely to disappear within our lifetimes even if the technologies supporting such a change were to become widely available. In literate cultures, books tend to evoke powerful aesthetic and emotional responses independent from their content. It is not likely that this deep-seated attachment to printed books will easily

disappear regardless of the intellectual advantages of electronic texts. Nonetheless, the inexorable pace at which electronic forms of written communication are expanding strongly suggests that educators must become familiar with the essential nature of electronic texts. Only then will we be able to lay the foundation for developing an electronic literacy that will prepare us for the future.

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